# DR. VAN RENSSELAER

ON

# SALT.

AN

# ESSAY ON SALT,

CONTAINING NOTICES OF ITS

## ORIGIN, FORMATION, GEOLOGICAL POSITION

AND

## PRINCIPAL LOCALITIES,

EMBRACING

A PARTICULAR DESCRIPTION

OF THE

## AMERICAN SALINES;

WITH A VIEW

OF ITS USES IN THE ARTS, MANUFACTURES AND AGRICULTURE.

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Delivered as a Lecture before the New-York Lyceum of Natural History.

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BY JER. VAN RENSSELAER, M. D.

One of the Curators of the Lyceum; Member of the Royal Medical Society of Edin.; Foreign Member of the Society of Encouragement, and of the Medico-Philan. Soc. of Paris; Memb. of the American Academy of Arts, of the Literary and Philosophical, and Medico-Physical Societies, N. Y.; of the Society of Arts, and Cor. Member of the Lyceum, Albany.


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# AN ESSAY ON SALT.

———— δ' ἁλὸς θείοιο.

———— sacred salt.

*Homer's Il.* ix.

However much geologists may differ in the classification or arrangement of rocks and soils, they all agree that what is termed the secondary, forms the most important portion of the habitable globe; furnishes the greatest quantum of soil cultivated by man; and yields at large the greatest proportion of those substances which contribute to his comfort and happiness.

The common division of rocks into primitive, transition, and secondary, has thus far been generally followed by scientific writers on the subject of geology. To me it seems probable, that future investigations will induce geologists to abolish the class transition, and to adopt a new one: in which case we shall have,

I. Primary, or Primitive.

II. Secondary.

III. Tertiary.

IV. Occasional; which last will include,

1. Volcanic Productions.
2. Coal.
3. Alluvia.
4. Clay and Sand.
5. Lignite and Peat.

The reasons for thus relinquishing the class transition are,

1. The limited extent of the formation.

2. The difficulty existing in discovering its line of demarcation.

3. Its total absence, in many cases, leaving the secondary resting on the primary.

In America, particularly, this opinion may be likely to prevail. In this immense continent the transition seems but as a band lying on the side of our primitive range of mountains. To the north-west it frequently changes place with the secondary, and is often so confounded with it as to lose its original features; while to the south-east there is no vestige of its existence, although it may be placed under the tertiary and alluvia that skirt our coast. To the north-west the secondary sandstone, in highly

inclined strata, reposes immediately on the granite, without the intervention of any transition rock. And yet in this country geological outlines are more distinct than in any other that geologists have examined. Where the sandstone of the coal formation reclines on mountain limestone, which lays on schistose rocks covering granitic mountains, the desire to abolish the transition gains fresh support.

Where transition rocks exist, they should be considered as belonging to the secondary region, since, strictly speaking, they are universally of that formation.

In our own country, the secondary, whether used in the usual acceptation, or in the extended sense I now propose, forms the greatest and fairest portion of our soil.

The primary range, extending like a spine through our Atlantic states, forms a support to the vast country stretching to the north and west; while on the south and east, it offers resistance to the force of the Atlantic, which has rolled to the tertiary, reposing at its base, the alluvial which forms so conspicuous and valuable a portion of our southern states. It seems, indeed, a giant arm, which, issuing from the north pole, has elevated our immense continent from the bed of ocean, and upholds it against the war of elements.

Reposing on the base of this primary, our secondary runs off to the west, until, interrupted by the Rocky Mountains, it reposes again on the primitive. It is covered on the south by the tertiary and alluvial of Alabama, Mississippi, and Louisiana, and composes nearly three fourths of the whole union.

In this secondary, as indeed in the secondary of every country where salt exists, is to be found the American salt formation. I use the word formation as it is generally used; and can only add my unit to the many who uphold the term, while they reprobate its use. Although not absolutely expressive of the idea intended to be conveyed, it is, nevertheless, full as explicit as most of the terms in any modern science, and should be retained until the unanimous consent of both hemispheres be obtained to the introduction of another, which, after all, may be better or worse, as chance may direct.

As an article, salt has ever contributed much to the comforts and luxuries of man, and has been known and used since the earliest ages. The antediluvians were acquainted with its properties and uses in an accurate degree, as we may judge from the mention made of it in the Old Testament. In the New Testament it is used by our Saviour as an emblem of perpetuity, as the symbol of wisdom, of incorruption of mind, and of sincerity.

Agreeably to the universal law pervading the whole creation of the Omnipotent, in which order and regularity are so conspicuous as to overwhelm the doctine of chance, salt is always accompanied by its own peculiar minerals ; these are red sand-stone, gypsum, clay, and coal.

The *plants* growing on the borders of salt springs are similar to those growing on the sea shore, viz. the triglochin maritimum, salicornia, salsola kali, astertripolium, glaux maritima, &c. On one part of our salt formation have been observed the atriplex, chenopodium and anabasis.

Independent of the vast accumulation of salt existing in the ocean, amounting to nearly one thirtieth of its whole, it is found solid, in the form of *rock salt*, and in solution in *brine springs*, from which it is obtained by the process of evaporation.

*Rock salt* exists in many countries, and is an article of extensive commerce.

Jibbel Had-deffa, in the kingdom of Tunis, is an entire mountain of salt, situate at the eastern extremity of the Lake of St. Mark. The salt is of a reddish, or purple colour, hard and solid as stone, and of a different quality and appearance from that of the salinæ surrounding it. A portion of it is washed

down by the dews, becomes white as snow, and loses the sharp bitterness of the parent rock.

The salt of the mountains near Levotaiah and of Miniss is of a grey bluish colour, and, without submitting to the like accidental purification, is quite agreeable to the palate. Of like quality and flavour is the salt from the Lake of St. Mark, the chief stratum of which is like a tessalated pavement, made up of various little cubes of common salt.

In the north of Africa it occurs, in great quantities, on both sides of the Atlas mountains. Mr. Horneman, on a journey from Cairo, discovered a plain, on a limestone range, which bounds the deserts of Lybia to the north, consisting of a mass of rock salt, spread over so large a surface that no eye could reach its termination; and its width he computed at several miles. To the south-east of Abyssinia is a plain of salt four days journey across, whence all that country is supplied.

Cardona, in Catalonia, is one of the most remarkable localities of rock salt. It seems to be an independent formation in a valley a league in circumference, the surface of which is covered with a vegitable soil. At one end of it is a promontory of red salt 660 feet high, without crevices, chasms, or layers. It is about a league in circumference, and in height equal to the surrounding mountains. As its depth is not known, we cannot say on what it rests.

In La Mancha is a similar mass of salt 70 yards in diameter, mixed with, and covered by, sulphate of lime, including crystals of red quartz.

Near the river Ebro a chain of hills, extending from east to west, is composed of salt, gypsum, and limestone.

Near Ockna, in Moldavia, is a hill of rock salt, in many parts of which the salt appears to view.

The Isle of Ormus, in the Persian Gulf, is said to be a solid mass of rock salt. Similar masses exist on the east of Persia.

In Caubul the rock salt rises in a cliff more than 100 feet above the river; it is hard, clear, and almost pure, and the road is cut in it. In some places it is streaked, or tinged, of a blood-red colour, similar to that of the earth in the vicinity. It is connected with red sand stone.

The valley of Paraid, in Transylvania, has the bottom and sides of solid salt exposed to view: the sides being mural, and more than 200 feet high.

In Cheshire, in England, is a salt mine worked since 1670, resting upon, and surrounded by red sandstone. It is roofed by clay, and the upper bed rests upon a stratum of clay, intermediate between the two beds of salt. There are several other beds of salt in England, affording a handsome revenue to the crown.

and allowing a greater quantity for exportation alone than is produced by any other district in the world: exporting annually more than 140,000 tons, or 5,000,000 bushels, and occasionally 236,000 tons, or 8,500,000 bushels; while the whole produce of the Polish mines does not exceed 7,000 tons, or one twentieth of the quantity usually exported by England.*

The long celebrated mines of Poland, or rather of Gallicia, since the dismemberment of that unhappy country, are the most extensive known, and form part of the greatest salt formation yet discovered.

They have been worked constantly since 1250. The extent of the mine is not known, although it has

* The value of the British salt works may be estimated from the following Table of exports from Liverpool.

| | U. States. | Elsewhere. | Total. |
|---|---|---|---|
| | *bushels.* | *bushels.* | *bushels.* |
| Exported in 1807, | 2,446,351 | 4,822,974 | 7,289,325 |
| 1808, | 2,514,670 | 5,630, 62 | 8,144,732 |
| 1809, | 1, 14, 86 | 4,854,202 | 5,868,288 |
| 1810, | 1,638,716 | 6,502,399 | 8,144,115 |
| 1811, | 1,870,368 | 6,722,122 | 8,592,489 |
| 1812, | 394,541 | 4,870,704 | 5,265,245 |

| | |
|---|---|
| In 1815 the revenue to the crown, from salt, amounted to | £1,616,612 |
| Of which went to the Collectors | 183,414 |
| Leaving a net revenue, of | £1,433,198 |
| or, | $6,363,899 12/100 |

been worked in every direction, and has been driven in one place 1200 yards by 400, and 240 yards deep. They are not confined to one side of the primary range, but are found on both edges of it. To the south-east the salt is solid, and so near the surface, that the rains wash off its covering of soil. The bottom of it has never been found. On the south-west, it is wrought by shafts and galleries; and the article is so plenty, that the miners are paid for such pieces only as weigh 40 killagrames, (more than 80lbs.)

These localities of rock salt are sufficient for our purpose; they are the most important; but there are many more, should it at any time be deemed necessary to draw geological conclusions, analogically, in regard to the position of our own salt formation.

I have mentioned that the ancients were acquainted with the nature and uses of rock salt. It seems probable that the columns of fossil glass, in which, according to Herodotus, the Abyssinians enclosed the mummies of their relatives, were only masses of rock salt, a substance very common in that part of Africa. According to the same author, the inhabitants of Lybia, so called by the ancients, built their houses of it.

Chardin, in his travels in Turkey, says, that it is

used for the same purpose in Caramania, where it is solid and hard, and the atmosphere very dry. And Pliny says, that in Arabia they construct houses of it, consolidating the whole by sprinkling water upon it.

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Many of the most productive and interesting localities of salt, are evinced by *salt springs*, affording brine, holding in solution, more or less, muriate of soda, which is extracted by evaporation. In speaking of rock salt, I should have mentioned, that many of the mines yield salt too impure for use. In such cases it undergoes simple solution and evaporation. This is the case with most of the salt worked in the vicinity of Nortwich, (England,) and the same is applicable to the Polish mines. Indeed, under the head of brine springs should be mentioned the Carpathian salt; for although that formation is worked by sixteen mines, and has more than forty other mines not worked, still it gives rise to about four hundred and thirty brine springs, nearly saturated with the mineral.

It is for this place that I have reserved the *American salt formation*, since, thus far, all the salt produced in our country, with the exception of sea or bay salt, has been procured by the evaporation of natural

brine. Rock salt is said to exist, in extensive strata, in Upper Louisiana, but its existence is doubted, although incrustations are seen in many places. The exploring expedition, commanded by Major Long, saw large masses of salt, weighing from 20 to 30lbs, but were unwilling to acknowledge it as rock salt, because it exhibited a crystalline structure interiorly. This, however, should not be deemed conclusive evidence against the existence of rock salt, or even as going to prove that these very specimens were not rock salt. It is sometimes found in plates, stalactitic, reniform, tuberose, cellular, and crystallized in cubes, which is the primitive form. Here is a natural specimen, having the primitive form beautifully defined, from Sicily, whence I brought it in 1819. These others are from Hungary and Poland; and, though native specimens, might by many be mistaken for artificial. The attempt to crystallize, on a large scale, is to be seen in one of the English mines, where the roof seems formed into something of a basaltic structure. So in Poland, too, is observed a similar polygonal structure supposed to arise from large globules pressed on all sides by others.

Although we have many large and valuable incrustations of salt, it is altogether certain that the moun-

tains of this mineral, which were formerly said to exist in Louisiana, were in a degree fabulous; though the springs of that country could afford sufficient salt for home consumption, should it ever be necessary to work them with that view. At present, perhaps, it would not be deemed expedient to attempt making more than we do, since we can import it cheaper than we can afford to make it.

Under the enlightened views of the present administration, there is little doubt that our natural resources will be brought to light, and put into operation, so far as the national welfare demands. The last step of congress, with regard to the salines of the west, that of granting them to the individual states in which they are situate, will tend to render them more productive. Thus all the salt springs in Illinois, including those in the vicinity of Shawneetown, have been ceded to that state. The salines of Missouri have not yet been leased out; but grants for working them can easily be obtained. Governor Miller, of Arkansas, is authorized to grant leases for the very valuable salt springs discovered in that state.

The works now in operation in the United States, yield annually about 1,200,000 bushels, of which the state of New-York furnishes more that one half, or about 700,000 bushels.

During the commercial year of 1822, there were exported from the United States 24,328 bushels of salt Our imports, during the same period, will be seen by the following statement, taken from the official report, viz.

| Where from. | No. of Bushel. | Value. |
|---|---|---|
| England, Man, and Berwick, - - - - | 1,692,398 | $307,451 |
| British West India Islands, - - - - | 781,194 | 114,549 |
| Swedish West India Islands, - - - - | 31,142 | 6,056 |
| Danish West India Islands, - - - - | 11,727 | 3,767 |
| Dutch W. Indies and American colonies, | 186,192 | 33,467 |
| Scotland, - - - - - - - - - - | 4,891 | 550 |
| Ireland, - - - - - - - - - - | 83,372 | 15,517 |
| Cuba, - - - - - - - - - - | 18,491 | 4,267 |
| Other West India Islands, - - - - | 11,673 | 1,723 |
| Spanish South American Colonies, - - | 642,972 | 64,686 |
| Gibraltar, - - - - - - - - - | 48,614 | 5,860 |
| British American Colonies, - - - - | 55,101 | 16,048 |
| Other British Colonies, - - - - - | 48,270 | 7,256 |
| Hanse Towns and Ports of Germany, - | 13,880 | 1,265 |
| Fren. European Ports on the Atlantic, | 98,440 | 8,319 |
| ——— on the Miditerranean, | 262 | 55 |
| Hayti, - - - - - - - - - - | 23,089 | 3,757 |
| Span. European Ports on the Atlantic, - | 61,263 | 4,400 |
| ——— on the Mediterranean, | 90,889 | 8,745 |
| Tenerife and other Canaries, - - - | 4,856 | 701 |
| Spanish South American Colonies,* - | 4,872 | 599 |
| Portugal, - - - - - - - - - | 642,972 | 64,686 |
| Fayal and other Azores, - - - - | 18,515 | 1,882 |
| Cape Verd Islands, - - - - - - | 54,836 | 4,572 |
| Italy and Malta, - - - - - - - | 90,733 | 8,826 |
| West Indies, - - - - - - - - | 10,395 | 1,590 |
| South Seas, - - - - - - - - - | 108 | 24 |
| Total. | 4,087,381 | $625,932 |

* It is probable that there is a mistake in this report, as the Spanish South American colonies are cited twice; and, in one instance, credited with exactly the same number of bushels as Portugal.

By which it will be seen that Great Britain, in conjunction with her islands and colonies, furnished us nearly two thirds of our whole comsumption, viz. 2,713,840 bushels, equal in value to $467,231, being at the rate of 16½ cents per bushel.

Thus there is a balance against us in the salt trade of 4,063,053 bushels, equal in value to $613,932.

No accurate estimate can be made of the quantity of bay salt, or salt from sea water, made in the United States.

According to a pretty correct calculation, the quantity of salt consumed during the year 1822 was about 6,500,000 bushels; so that the bay salt manufactured must have amounted to more than one and a half million of bushels; the sum total of which was produced by the eastern and southern states. The extensive works in Massachusetts were very productive some years ago, but were suffered to decay, until restored by the liberal spirit of some enterprising individuals. They now furnish a very considerable supply, which is used in that state for the curing of fish. A few years since light roofs, moveable on rollers, were erected to protect the works from the summer rains; but the cost, being one thousand dollars for the erection of ten thousand superficial square feet, was more than the proceeds warranted. At

present there are on Cape Cod, 600,000 feet of vats, or pans; on the other shores of the state, about 200,000 feet, making collectively 800,000, giving an annual average of 300 bushels of salt to 1000 feet of works, or 240,000 bushels for the whole state. Rhode Island and Connecticut furnish individually a large share of bay salt.

The southern Atlantic states enjoy a climate admirably adapted to the evaporation of sea water, their long and hot summer allowing sufficient time and heat. On the coast of North Carolina, works were erected in 1810, covering 275,000 square feet. I do not know if they have answered the sanguine expectations of the projectors. But if properly conducted, they should afford nearly a sufficiency for the whole country. In a higher latitude of France they produced, by the evaporation of sea water, in one month, nearly enough for the home consumption of the whole kingdom during the year; and the sea water there is not quite so salt as on our southern coast. The production of salt from the ocean is always of consequence, and more particularly to those states possessing no salines, and having no inland navigation to such states as have salt works. In Wilmington, North Carolina, only 34 miles from the coast, salt was sold, during the last war, at seven dol-

lars per bushel. Bay salt is frequently superior to rock salt for the purposes of preserving provisions; and so firmly are the English persuaded of this fact, that during peace they import salt very largely from France and Holland. In France salt pays a duty to the crown of thirteen and a half francs per bushel; the manufacture of which from sea water costs about ten cents: so that the duty amounts to twenty-seven times the original cost.*

That part of the shore of New-Jersey situate between Sandy-Hook and the Delaware bay, is well adapted to the manufacture of salt from sea water. If properly erected and managed, the works, at a comparitively trifling expense, might be made very productive.

In France, according to Necker, the annual consumption of salt was an average of 14lbs. to each

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* The government of France appears to have been as impolitic with regard to this tax as the English. Buonaparte abolished the collection of turnpike dues, and imposed a tax on salt, payable at the salt pans, in its stead. It is not perhaps generally known, that by the aid of this tax he was enabled to complete the grand entrance into Italy, over the Simplon: so that it may fairly be observed, that if Hannibal was enabled to cross the Alps by the aid of vinegar, Bonaparte, by the assistance of salt, succeeded in constructing a public road over the same mountains.—*Paris Pharmac.*

individual. In Cumana and Barcelona, according to Humboldt, the average consumption is 60 lbs. per individual. In the United States, 36 lbs. is the average consumption of each person.

It appears, from a careful examination of the most accurate returns, that the European salt mines and springs afford annually thirty million hundred weight of salt; equal to about fifty millions of bushels.

Although salt may, as has been supposed, be one of the universal formations, having an extent equal to the stratafied rocks, yet it seems rather an independent formation, in which salt may have been formed at the same or different times, but under the same laws, in different parts of the same continent.

The *American salt formation* extends over the continent, from the Alleganies to the North Pacific, between 31 and 45° north latitude. In this immense tract rock salt has been occasionally found, but its locality is more generally pointed out by brine springs.

In Peru, indeed, in South America, but which is not included in this formation, rock salt, at the surprising height of 10,000 feet, on the grand chain of the Andes, is found in hard blocks, and forms solid

continuous rocks. The exterior form of the salt strikes at first sight, for it resembles a stone of a dull violet colour, strewed with rays of jasper. These mines of salt are found nearly all over the country; and what is worthy of remark, is its extreme hardness, its colour, and that it should be in those mountains equally as high as those which yield silver or mercury, which is certainly extraordinary.

At Punta Araya immense blocks of it are taken from the muriatiferous clay. The south bank of the vast gulph of Cariaco is impregnated with muriate of soda, and was once covered by the ocean, as incontestibly, says Humboldt, as the basins of Paris, Rome, or Oxford. The salt at Araya was known to Alonzo Ninno, when, following the steps of Columbus and Amerigo Vespucci, he visited these countries in 1499, and was, perhaps, the earliest discovered in America. At that time the Guayquerias dug into the muriatiferous soil of Punta Arenas. The brine pits of Cape Araya were worked at very early periods. The Spaniards, who settled at Cumana, in the begining of the 16th century, worked the salt marshes, which have since been in operation. At that period the Dutch secured to themselves the peninsula of Araya; and in 1605, the court of Madrid sent armed ships to expel them by force of arms. At present

each province has its own salt works, and of so little consequence are they estemed by the mother country, that the merchants of Spain and Portugal send salt to cure meats at Monte Video and Bueonos Ayres, a distance of 1900 leagues. In 1799, the salt works of Araya yielded a clear income of 8,000 piastres.

Though manufactnred with less care in the peninsula of Araya than at the salt works of Europe, it is nevertheless purer, and contains less of the earthy sulphats and muriats.

In Mexico the salt lake of Pennon Blanco yields annually 250,000 fanegas of unpurified salt, of 400lbs. each.

In California rock salt occurs in very large quantities.

Approaching homewards, and crossing the primary chain, which by some may be considered as the western boundary of the *American salt formation*, salt is found in abundance on the plains east of the Rocky Mountains, in incrustations, covering lands of some extent. The exploring party under major Long, however, saw none that they considered rock salt, but rather such as was the effect of evaporation, being crystalline salt, formed, by the desiccation of some salt lake, into concrete masses, or crusts, upon the ground, having red sandstone attached to them.

The great saline to the south west of Fort Osage has a circumference of 30 miles, which, in many places, is covered with drift wood, scattered over it by the streams near to it. The salt lies from two to six inches deep, and forms a crust very beautiful, clear, and white, much superior to the common imported salt. It is associated with gypsum and clay.

The existence of these incrustations is sufficient indication of their connection with beds of salt. The fact of salt brine springs being found in red sandstone, is enough of itself to warrant the conclusion. Not that red sandstone may not exist without rock salt, but it may be doubted if rock salt ever exist, in quantity, in other strata except in muriatiferous clays; the few exceptions that we know of going to prove the general rule.

The whole country near the Rocky Mountains abounds in licks, brine springs, and saline efflorescences; but it is near the red sandstone that salt is met with in greatest abundance and purity.

The immediate valley of the Canadian River, in the upper part of its course, varies in width from a few rods to three or four miles, but is almost invariably bounded by precipices of red sand-rock, forming the river bluffs. In the valley between these, incrustations of nearly pure salt are found,

covering the surface to a great extent, in the manner of a thin ice, and causing it to appear, when seen from a distance, as if covered with snow.

The waters of the country, between the meridian of the Council Bluffs and the Rocky Mountains, in almost every part of it, appear to hold in solution a greater or less proportion of common salt and sulphate of magnesia, rendering them frequently too brackish and bitter for use. The whole of this country is said to bear a manifest resemblance to Siberia, abounding in rocks and soils strictly saline.

The saliniferous sands of the Siberian plains are supposed, by Patrin, to be derived from granitic mountains, containing muriate of soda, and which, he thinks, has been one cause of the destruction of many of them, and which at this day promotes the decomposition of many that still remain. I know not if he would attribute to the same cause the saline efflorescences found on the sandy plains of Tartary, in arid Arabia, in scorched Africa, and on the immense plains of India and Persia.

*Illinois* abounds with salt. The most important work is near Shawneetown, where there are now seven furnaces in operation to extract salt from the water of three wells, which used to flow on the sur-

face at the rate of sixteen gallons per minute. These works, which have produced 200,000 bushels in a year, at present yield 150,000 bushels, worth about 70 cents on the spot. Two hundred and fifty gallons of brine yield 50lbs. of salt. Near one of the wells is a basin-shaped cavity of about four hundred feet in circumference, the soil in and about which is intimately blended with fragments of earthenware. In the centre of it a well has been sunk, which affords a more concentrated brine, 110 gallons yielding 50lbs. of salt. Circumstances countenance the idea that this spring has been worked in early ages; perhaps, by the aborigines. In digging this well, the first fourteen feet were a slight earth, mixed with ashes and fragments of earthenware; the remaining fourteen were through a bed of clay, deeply coloured with oxyd of iron, and containing fragments of pottery. The clay has something of the appearance of having been subjected to the action of fire. In a drain, which seems to have answered the purpose of carrying away superabundant water, is a layer of charcoal, six inches deep, and four feet below the surface. The stones in the vicinity seemed as if they had been burnt.

I should mention that charcoal is found above all the salt mines and brine springs of the Carpathian formation.

Four miles west of this point is another well, sixty feet deep; in digging, the workmen struck,

1. A bed of tenacious blue clay, 20 feet thick, at the bottom of which is a small spring of salt water.
2. A bed of similar clay 25 feet thick, and,
3. A quick sand bed of 10 feet, at the bottom of which is a large vein of salt water.

Bones of the mammoth and other animals were found in both the clay and sand.

The original reservation at these salines comprised 92,160 acres of woodland, and was transferred by the United States to the state of Illinois, which now derives from its different salines an annual revenue of about $10,000.

In *Missouri*, Boon's Lick, long known, furnishes the wants of the neighbouring settlements. Several furnaces are erected for the evaporation of a weak brine; 450 gallons of which yield a bushel of salt. Eighty bushels are made daily, and require three cords of wood. Compact limestone is the prevailing rock; but coal beds and strata of sandstone abound in the vicinity.

Lockhart's salt works, on the Saline River, yield 500 bushels of salt per week. The *diggings*, so often

mentioned as existing here, seem to have been produced by wild cattle, resorting hither in large herds, and licking the ground for the sake of the salt contained in it. Four miles further north, on the Saline Fork of Le Mine River, is another establishment, where 180 gallons of brine produce a bushel of salt. One hundred bushels are manufactured per week, and eight men are employed in the works.

There are several small works for the manufacture of salt in other parts of this state.

In *Arkansas*, independent of the saline incrustations, there are many valuable salt springs. On the Grand, or Neosho river, 50 miles above its junction with the Arkansas, in an alluvial basin, are valuable salt water springs, quite pellucid, issuing copiously from the surface in various directions. One of the springs emits fetid bubbles of sulphuretted hydrogen gas. The only well dug for salt water is about five feet deep; eighty gallons of brine produce a bushel of salt, and 120 bushels are manufactured weekly. The water is said to be so strong, that after the second boiling it is not necessary to remove the lye. The salt is pure white on the first boiling, and is said to contain none but volatile impurities. The well is in dark-coloured limestone, containing shells. No marine plants appear in the vicinity.

On the Illinois, a few miles above its junction with the Arkansas, are Bean's salt springs. They are similar to, and scarcely less productive than those on Grand River. In digging his wells, the workmen struck, about two feet from the surface, a stratum of charcoal, which affords conjectures, at least, that this locality has been known and worked by the aborigines.

On the Wachitta are springs yielding a large proportion of the muriate of soda; but I am not prepared to say exactly how many bushels are manufactured yearly; the quantity has been estimated at 50,000 bushels.

Most of the streams north of the Arkansas are said to possess salt, which might be wrought with profit; on the north side of the Arkansas the salines are connected with the coal formation; on the south they occur in red clay.

In *Ohio* are many salt wells; that of Zanesville, on the Muskingum, is 213 feet deep, and furnishes 80 bushels of salt daily; 95 gallons of brine give a bushel, worth on the spot $1 50 In Jackson, on the Scioto, and on the Hockhocking, are several salt springs; in one a shaft has been sunk 300 feet: but the brine has proved weak, requiring 213 gallons to

the bushel. There are many other springs in this state, some of which are very valuable.

In *Kentucky* the salines of the Little Sandy River are the most productive, yielding annually about 10,000 bushels. The waters, like those of Kenhawa, &c. hold in solution, besides the muriate of soda, the sulphate of soda, sulphate of lime, and a small portion of the sulphate of magnesia. Limestone and sandstone are the only rocks found in the vicinity. The brine at May's lick issues from alluvial argillaceous soil. There are other salines, yielding about ten thousand bushels.

In *Virginia* are several valuable salines ; the most important are in Wythe county, and on the Grand Kenhawa River. The latter has a very strong brine, 95 gallons yielding a bushel of salt. The whole produce of this work is 30,000 bushels yearly. The rocks in the vicinity are secondary, and connected with lime, variegated sandstone, and bituminous shale. All the salt of this state is connected with gypsum.

In *Pennsylvania* the works on the Conemaugh Creek produce upwards of 100 bushels a day, which

sells at nearly two dollars per bushel. After various attempts for 28 years, and sinking a shaft to the depth of 373 feet, the greater part of the way through solid rock, a good supply of brine has been procured in Susquehanna county, where excellent salt has been manufactured from it. Preparations are making to carry on the manufacture in an extensive manner.

In our own state are numerous and productive salt springs. In fact, *New-York* possesses inexhaustible sources of wealth in her brine springs, extending through the counties of Onondago, Cayuga, Seneca, Ontario, Niagara, Genessee, Tompkins, Wayne, and some small unwrought ones in Oneida. The most important now worked are those of Onondago, of Montezuma, (Cayuga county) and Galen, (Wayne county,) which I shall describe.

The Onondago, or Salt Lake, as it is frequently termed in its vicinity, is six miles long and two miles broad; it is supplied by the Onondago and Otisco Creeks, and emptied by the Otsego River into Lake Ontario. The lake, with its vale, is surrounded by hills of limestone containing organic remains. Abundance of gypsum has also been found associated with the salt, in the same manner as has been observed in Europe.

The most easterly point at which salt springs have been observed in New-York is about twenty-five miles west of Utica; forty miles farther west are the salt springs of Onondago. The most westerly point at which they have been as yet discovered is at Saint Katherines, in Canada.

The country, or valley, of the Onondago is several feet below the level of the adjacent plains, and consists of an indurated red and green clay, with their intermediate varieties, resembling the substance brought from Arran, and described by Professor Jameson as indurated lithomarga. The springs rise to the surface on the borders of the lake, and even far up the creek supplying it with water. On the borders of this creek, springs of fresh and salt water rise within a few feet, and, in some instances, within a few inches, of each other. The quantity of salt held in solution varies greatly in different springs, even in those that are contiguous. The strength of the brine is influenced by the temperature of the season. During the last summer, which was there a remarkably dry season, the springs continued to discharge their usual quantity of water, but it was weaker than had been before observed. Many of them are deserted on finding others of a stronger brine. The strength of these springs is comparatively very great, as will

be seen by the following list of brines, and their products:

| | | | | |
|---|---|---|---|---|
| At Nantucket, | 350 | g's of sea water | give a bushel | of salt. |
| Boon's Lick, (Miss.) | 450 | gallons of brine | do. | do. |
| Conemaugh, (Pen.) | 300 | do. | do. | do. |
| Shawneetown, (Illi.) | 280 | do. | do. | do. |
| Jackson, (Ohio) | 213 | do. | do. | do. |
| Lockhart's, (Miss.) | 180 | do. | do. | do. |
| Shawneetown (2d s.) | 123 | do. | do. | do. |
| St. Katherines(U.C.) | 120 | do. | do. | do. |
| Zanesville, (Ohio) | 95 | do. | do. | do. |
| Kenhawa, (Virg.) | 95 | do. | do. | do. |
| Grand River, (Ark.) | 80 | do. | do. | do. |
| Illinois River (do.) | 80 | do. | do. | do. |
| Salina, (New-York,) | 45 | do. | do. | do. |

The brine of Onondago has never been accurately analyzed. The following statement, made some years ago by Dr. Noyes, of Hamilton College, has never been published. It is to be considered rather as an approximation. He estimates 40 gallons, or 355lbs. avoirdupois of brine to produce 56lbs. of saline extracts; of which is,

| | lb. | oz. |
|---|---|---|
| Pure muriate of soda, | 51 | 00 |
| Carb. of lime color'd by oxyde of iron, | 0 | $6\frac{1}{2}$ |
| Sulphate of lime, | 2 | 4 |
| Muriate of lime, | 1 | $12\frac{1}{2}$ |
| Muriate of magnesia, perhaps | | |

It is to be remarked, that in this statement is not mentioned sulphate of soda, which is most probably present in very considerable quantity.

A complete analysis of this water may soon be expected from the Professor of Chemistry in the University of this state.

The salt springs and the surrounding country belong to the state; but permission is given to any person, under certain limitations, to erect works and extract salt, upon paying into the treasury a duty of 12½ cents per bushel of 56lbs. The leasing of the salt lots has been regulated by the legislature.

Under the head of Onondago are usually comprised three villages, and their works, viz.

| | | |
|---|---|---|
| Salina, | where there are 50 | furnaces or blocks. |
| Liverpool, | 20 | do. |
| Geddesburgh, | 13 | do. |
| | Total 83 | |

averaging each fourteen kettles, and each of them calculated to produce forty bushels a day, amounting to 3,320 bushels, or 664 barrels, at the rate of more than 1,000,000 bushels annually;* which has a ready sale on the spot at from $1 75 cts. to $1 81 cts. per barrel; making one day's manufacture $1162.

When the western canal is opened, it is supposed the salt from these works can be afforded, at Albany, at 37½ cents per bushel. While the canal was only partially opened, there were cleared at Syracuse, from April 18th to September 11th, 34,798 barrels, or 173,990 bushels of salt.

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* This is calculated on the fact that every day is employed, which is not the case.

The politeness of the comptroller has allowed me to copy from the state returns the quantity of salt inspected at these works, during the year ending August 6th, 1823, viz.

| | | | | | Revenue. |
|---|---|---|---|---|---|
| Aug. 7, to Nov. 5, | 1822, | 145,626, at | 12½ cts. | per b'l. | $18,203 25 |
| Nov. 6, | May 20, 1823, | 300,862, | do. | do. | 37,607 75 |
| May 21, | Aug. 5 | 159,975, | do. | do. | 19,996 89 |
| | Total, | 606,463, | | | $75,807 89 |

The revenue from these works is yearly augmenting. n 1800 the quantity of salt manufactured amounted to 42,754 bushels. In 1814 the superintendant reported 295,215 bushels of salt manufactured and inspected at the works of Onondago. The state duty was three cents per bushel, and the nett profit, after paying all expenses, was $7,303 87 cents, to the government, of which $5,200 was expended upon roads.

The springs now used are all situate on the marshy edge of the lake. The one first worked is said to have been at Green's Point, between Liverpool and Salina. A strong wooden curb is settled down from six to ten feet, and, until recently, the water was pumped out by hand. The principal source whence all the works are now supplied, is termed the Horse Spring, and is furnished with a powerful forcing pump, raising the water seventy feet above the lake, and giving 120,000 gallons per twenty-four hours.

The brine is conveyed by wooden pipes to the distance of two miles, supplying the villages of Geddesburgh and Syracuse. The supply of water, and, of course, the works, may be increased indefinitely. The forcing pump belongs to individuals, who receive two mills per bushel on all salt manufactured at the works.

There are three kinds of salt manufactured at these villages; the common fine, the rectified fine, and the coarse salt. The common fine is made in the greatest quantity. The process employed seems to be very slovenly, and until lately many complaints were made of its quality. Legislative interference has abolished the causes of these murmurings, and introduced a better system of manufacture. The method now employed does not differ materially from that used in other countries. From twelve to sixteen kettles, holding from ninety to one hundred gallons each, are firmly set in brick work over a furnace. They are about three feet deep, and two in diameter. The form and size might be materially improved: they are certainly much deeper than necessary. The foreign substances, (or bittern, as it is technically called,) is first extracted, and then the salt. The only mode they appear to possess of determining when the bittern is extricated from the brine, seems to be by observing how much of the water is evapo-

rated. They then dip it out, and by observing a certain point to which the brine is boiled away, commence taking out the salt, which is thrown into a basket, suffered to drain for a few minutes, and is then fit for use. It may be readily imagined, from this rude process, that the salt cannot be very pure. It contains much muriate of lime, which adds to its whiteness, while it destroys its purity. It is thereby rendered in a great measure unfit for its most important use, *i. e.* preserving provisions. It is estimated that each kettle will produce five bushels every twenty-four hours, requiring two cords of wood for the furnace during that time.*

The refined, or rectified salt is made in small quantities here; it is intended for the table, and comes to this market in small boxes and baskets of from 1 to 3lbs. each. It is equal to the finest imported.

The manufacture of coarse salt has lately been commenced at Syracuse, in the vicinity of the other works. It is produced by solar evaporation alone. The brine is poured into large shallow vats, furnished

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* It is much to be regretted that no competent person has been found to take charge of these works: thus far there has been a deficiency of knowledge manifested by the agents employed. It is most sincerely to be hoped that the companies now engaged may meet with a man who to zeal will unite intelligence.

with covers to protect them from the rain. The marsh mud and bittern being precipitated, the brine receives the technical name of pickle, which is drawn off into vats, and the deposit formed. The precise point at which the brine is converted into pickle, is determined by the appearance of cubical crystals of salt floating on the surface. Very little has, as yet, been manufactured; but the proprietors are now erecting works, where it is intended to produce annually 100,000 bushels; and from the known enterprise of the gentlemen most largely concerned, there is no probability of a miscalculation.

It is the general belief at Salina, that great masses of salt exist, and may be discovered near to the surface; and the legislature have granted certain powers to persons searching for the mineral, securing to them certain valuable privileges on the successful termination of their search. With the aid of such strong stimulus, added to the usual hope of gain, we may hope that fossil salt will be discovered, as it doubtless does exist in the vicinity, although, perhaps, at a considerable depth. Unless it should prove very pure, however, it would be necessary to redissolve it to obtain the salt of commerce. In which case it is at least problematical if it would add much to the value of the manufacture.

From the springs in the town of Salina, (including the villages of Salina, Syracuse, Liverpool, and Geddesburgh,) it is calculated that at least three millions of bushels could be made annually, should the demand justify it, yielding the state a yearly revenue of $575,000.

Montezuma, in the county of Cayuga, embraces salt springs of great value. The works are owned by a company engaged in the manufacture of refined, or rectified salt. From the books of the comptroller I was politely allowed to copy the returns, as follows, showing the quantity of salt made, the revenue to the state, and the expense:

| Inspected, from | Bushels. | Revenue. | Com. to Supdnt. at 7 1-2 per cent. |
|---|---|---|---|
| Aug. 1, to Oct. 31, 1822, | 3,332 | $416 50 | $31 23 |
| Oct. 31, 1822, to Jan. 31, 1823, | 5,031½ | 628 93 | 47 16 |
| Jan. 31 to April 30, 1823, | 3,207½ | 400 93 | 30 06 |
| April 30 to July 31, 1823, | 2,726 | 340 75 | 25 55 |
| | 14,297 | 1787 11 | $134 00 |

In 1810 the county of Cayuga furnished nearly 60,000 bushels of salt. How much is made at present I have not been able to ascertain.

In the county of Wayne, the town of Galen manufactured about 150 bushels daily, in 1810; making an average of about 50,000 yearly. There are several other valuable salt springs in this county.

Genesee county contains several valuable salines;

but they are not extensively wrought, yielding only a few thousand bushels a year.

Seneca county enjoys fine salt springs in Wolcott and the neighbouring towns; but they are not productive at present.

The salt springs in the counties of Ontario, Niagara, Tompkins, and Oneida, have not been used thus far in the production of salt. They are individually of great worth to the proprietors and to the state, and will soon be made productive.

All the salt springs in our state, so far as my information extends, are connected with lime and clay.

The benefits derived from our salines may be appreciated by knowing, that before salt was brought in quantity from Onondago, that necessary article sold in the western parts of Pennsylvania for five dollars a bushel; which, when we compare the value of money at that time with the present standard, gives nearly double the price. Since salt has been furnished by the Conemaugh and Kenhawa works, it has fallen in price to less than three dollars per barrel.

The strength of our salt springs is, upon an average, greater than those in Europe, though it is a matter of

no practical moment at the present day. It should be remembered, however, that many European brine springs have been estimated too highly. It has been repeatedly said, for instance, that the brine springs of Barton and Northwich, in England, yield six ounces of salt to the pound of brine, or more than one fourth part pure salt. Now, experiment proves, according to the minute investigations of the bishop of Landaff, that this cannot be true; for allowing that sixteen ounces of water can hold six ounces of salt in solution, and no more, it follows that no brine spring can yield six ounces of salt from a pint of brine, because sixteen ounces of water with six ounces of salt would be a saturated brine of twenty-two ounces : therefore, if twenty-two ounces of brine yield six ounces of salt, sixteen ounces of brine can yield only four and four-elevenths ounces of salt. So that the strongest brine can yield very little more than one fourth part its weight of salt. Cheshire salt brine gives twenty-two per cent. ; in one remarkable case it gave twenty-five per cent. ; and once twenty-six per cent. of salt.

In Switzerland, from thirteen to fourteen per cent. is the usual strength of the salt brine springs. In France, eleven per cent. is the average.

Most, or perhaps all our brine springs are original or primary sources. *Sources* are of two kinds:

1. Those which rise immediately over the bed impregnating the water, or from a stratum immediately connected with it, though perhaps at some distance from the fossil.

2. Those which rise from a collection of salt water made in a stratum not immediately connected with the impregnating mineral.

It is not essential that a spring should rise immediately over a mineral charging its waters; because, after being impregnated, it may flow over an impervious stratum, as grauwacke, for example, and rise, at a very considerable distance, pure and valuable brine; it is still a primary source. But a body of water flowing over salt, or any other mineral, and oozing through different strata, until it reaches one that it cannot percolate, and then follows it till, from some cause, (in what manner it matters not,) it rises to day, is a secondary source; because it neither rises over the mineral, or any stratum immediately connected with it.

In mountainous countries particularly, this is a subject of much importance, as the hopes of success are founded upon permanent sources, which the secondary never are; being liable to be diverted from

their present channels by slight obstacles, and to rise in other places. Some of the salines in Switzerland are worked on this principle of sources, and it often happens that a vein of water is intercepted, and leaves the brine spring dry.

At Halle, in Germany, and at many other places, mines are worked by cutting parallel galleries in the parent rock, and forming dykes, to turn water into them, where it remains until saturated. It is then drawn off and evaporated. In most cases judgment and experience are necessary in drawing water from salt pits, whether natural or artificial, where it reposes immediately on the salt. As the stratum of saturated water next the salt has an increased specific gravity, and will remain at the bottom, preventing the great volume of water from coming in contact with the mineral to be saturated in its turn, it is necessary to keep the water in motion. Experience has proved the great utility of this expedient, which will saturate the water in a much more expeditious and effectual manner than by allowing it to remain at rest.

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Of the *Geological situation* of the American salt formation, a general idea has been given in assigning boundaries to our secondary region.

On comparing the geological relations of the great proportion of beds of rock salt and brine springs, it will at once be seen that they are most frequent at the base of mountain chains. The Carpathian salt, accompanying that mountain chain for 600 miles on either side, is a proof of this. That formation embraces the salt mines of Poland, Moldavia, Upper Hungary, and Transylvania, and is perhaps the most important known. The Swiss springs at Salins and Montmorat are at the foot of Jura. The principal salt formation of England is at some little distance from the west side of the hills, dividing the rivers that flow into the eastern and western seas. The most productive of our own springs are not far from the base and termination of the Allegany Mountains.

*Red sandstone* is so intimately connected with salt, that by many it is considered as its peculiar repository. It is associated with our salt from the Allegany to the Rocky Mountains and Lake Huron. It exists with the salt of Cheshire, Northwich, and Droitwich, in England; at Cardona, in Spain; at the foot of the Carpathian Mountains in Moldavia and Poland; and in the higher regions of Peru. Similar to the same mineral, fragments of the immense bed once covering the whole valley of the

Mississippi from the Allegany to the Rocky Mountains, are to be seen, in situ, at the foot of the High Peak, where lofty and detached columns of dark red sandstone are irregularly scattered through a valley, some of them rising 300 feet above the plain, and perfectly inaccessible. It is also to be seen at the falls of the Missouri, on the Red and Canadian Rivers, on the borders of New Mexico, and on the Arkansa, and more than probably, according to Dr. E James, extending to the Red Rivers of Mexico, where it is covered with grey sandstone. The exploring expedition under Major Long saw incrustations of salt which had been deposited by water flowing from the red sandstone hills in the vicinity, which are traversed in various directions by veins filled with gypsum. Near the Lake of the Hills Sir Alexander Mackensie mentions that brine occurs in red sandstone.

In this red sandstone formation are the salines of Onondago, and we know not how far it may extend, or in what manner be connected with the stores of this mineral, supposed to exist at the north pole. In many places it passes under the secondary, and contains coal, gypsum, and brine, and, perhaps, says Governor Clinton, indulging the same ideas with

Maclure, supports the vast horizontal formation extending past Niagara to the unexplored north.

The red sandstone is one of the most extensive European formations, and besides supporting some of the most fertile parts of England, and the continent, comprises, what is termed by the English geologists, the inner basin of Europe. It forms also great part of Tartary, of Arabia, Persia, and Africa. Its decomposition proceeds from the iron it contains; so that a metal of the greatest utility may, in the field of battle, or in the dreary desert, become the most pernicious to the human race. Well then might it occur to an Elector of Bradenburgh, the lord of a sandy region, to inquire, why God had created sand?

*Sulphate of lime* or *gypsum* is frequently found in connection with salt, or in its immediate vicinity.

It is a singular circumstance that two of the most powerful acids in nature should be found so intimately united, and almost blended, as is the case with the sulphuric and muriatic. We find sulphate of lime and muriate of soda in contact. Thus, at Arbonne, the gypsum is so strongly impregnated with salt as to be worked for the purpose of extracting it. Owing to their intimate union, salt usually contains a portion of gypsum, which is deposited during evaporation.

At La Mancha, in Spain, salt is mixed with, and covered by, gypsum. In the valley of Egarement, in the south of Africa, there are beds of salt resting upon it. At Onondago the salines are surrounded by it.

I cannot take it upon me to say that this gypsum, as is sometimes supposed, is formed by the decomposition of iron pyrites supplying the sulphuric acid, which unites with the subjacent lime. This however might receive confirmation by a knowledge of the fact that marl and sand over gypsum generally, and especially when in connection with salt, has the red tinge belonging to the oxide of iron.

In digging or boring for salt, it is generally observed, that the quantity of lime increases as the salt bed or spring is approached.

*Clay*, or marl, is most commonly found associated with salt, and by the miners is named metal. It forms beds covering, and sometimes alternating with, the salt; it is frequently mingled with it, and contains large isolated masses of it.

At Weilitzka it forms a bed of ten yards deep over the salt: at Wilton, near Northwich, (in England) there are nineteen distinct strata of clay and marl, mixed, more or less, with sulphate of lime, over the

first bed of rock salt, and another between that and the next stratum of salt. At Punta Araya the clay contains large masses of fossil salt, and is also impregnated with the muriate of soda. At Shawneetown there is a stratum of blue clay, twenty yards deep, over a saline spring.

In connection with the clay are often banks of sand and lime, containing organic remains; viz. teeth of mammiferous animals, fossil shells, carbonized wood, and bitumen, penetrating the clay, and giving its odour to the salt. Bivalve shells are found at Cracow, seventy-two yards from the surface; crabs' claws at eighty yards; charred coal and salt and gypsum at two hundred yards: all of which go to prove an hypothesis presently to be supported, affirming beds of salt to be deposits from the ocean.

*Coal* is frequently found in connection with salt.

In this country, as in most of the salt formations of Europe, rock salt seems to have been formed previous to the coal, being in beds having a geological position subsequent to coal formations. This is proved particularly at Liverpool, in Ohio, where a salt well yielded half a barrel of petroleum daily. The salt mines in Transylvania contain much petroleum, oozing into them. In lower coal strata, par-

ticularly in basin-shaped cavities, which have the appearance of having once been lakes, brine springs are occasionally found. Near the Lake of the Hills, rock salt and coal are found in red sandstone.

It is more than probable that the coal and salt formations keep pace with each other, on the west of the Alleganies, from Onondago to Ohio and Kentucky. The strata in which the latter is found invariable abound with impressions of culmaria and zoophytes, so common to coal fields.

*Sulphur* is occasionally found with salt, but very rarely, as in Sicily.

Other substances have been found, but very seldom with salt, united so as to form pebbles, in clays that are much distorted, and have thin beds irregularly placed. They are sometimes mixed, and minutely broken up, so as to form a brecchia, as at Bex, in Switzerland.

In every department of science we find occasional deviations from customary laws; even in animated creation nature not unfrequently plays faotastic freaks in the production of monsters. Salt, in like manner, is sometimes found out of its usual situation. Thus, it is found, in what is called transition, near Madrid. In Castile is a mine of rock salt in the vast crater

of an extinct volcano, in which have been found pumice, puzzolana, and other volcanic productions.

In the midst of the higher Alps, in the department of Mount Blanc, (Savoy,) and near St. Maurice, at the confines of the region of perpetual snow, is a salt rock, composed of sulphate of lime and muriate of soda, in such proportions that salt for use is extracted from it by the usual process of solution and evaporation.

It is this, probably, that caused the observation of the geognost, that we should not be surprised to find salt among the primary rocks, and that he expected to do so.

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To account for the *production of salt*, in the first instance, it may be supposed that marine plants may be constantly emitting chlorine gas just as terrene plants are giving out oxygen, and that their decomposition furnishes soda, which unites with the chlorine, after it has absorbed a sufficiency of oxygen from the water to become muriatic acid gas. Thus, submarine vegitation, constantly going on in the bosom of the ocean, supplies all the elements necessary to the production of fossil salt.

In support of this theory it may be added, that in

such lakes, or inland seas, as produce no marine vegetables, the waters are fresh and sweet. In the Black Sea there are no plants of marine growth, and the waters are scarcely brackish; yet the shores of the Black Sea, in all directions, abound in fossil salt; which at least proves, that this sea does not receive its saltness from the fossil salt in its vicinity. Nevertheless, it must be conceded, that as no human ingenuity has, as yet, succeeded in making marine plants vegitate any where but in the bed of the ocean itself, it will be most difficult to bring the hypothesis to the test of experiment, the only touchstone of truth.

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As to the *origin of rock salt*, the most satisfactory hypothesis is the supposition of its being deposited from sea; or by the dessication of salt lakes formerly covering our present continents. The objection that the composition of rock salt is more pure than that from the sea water, which contains also sulphate and muriate of magnesia, sulphate and muriate of lime, and sulphate of soda, is invalidated by the recollection that whatever impurities may exist in sea water, still, if the process of evaporation be conducted very slowly, the crystals are nearly pure.*

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* I may here add, though perhaps not strictly in place, that muriate of potash has been discovered in the rock salt of Upper

In some places the process is conducted so well, as at Lymington, in England, where it takes 12 days, that from the most impure, or mother water, it still contains only 12 parts in the 1000, or little more than 1 per cent. of impurities. If, then, the desiccation of lakes, or basins filled with salt water, be very slow, as it must be when the process is to be finished by natural evaporation, the muriate of soda would be crystallized before the other salts, which being more deliquescent, might be separated and washed away. In the same way, the gypsum that usually accompanies salt might be deposited, and being nearly insoluble, would remain.

That lakes of salt and fresh water have once covered much land, is not to be doubted in the face of so many incontrovertible facts as can be brought forward. Our own day offers proofs of the changes

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Bavaria and of Hallein. When dissolved in water, and freed by evaporation, of the greater part of sea salt which it contains, it precipitated the muriate of platinum. The precipitation, when calcined with oil, and heated with nitric acid, gave crystals of the nitrate of potash. The water of the saline of Rosenheim, in Bavaria, when evaporated, likewise precipitated the muriate of platinum.

It is a singular coincidence, that about the same time that potash, in the form of a muriate, was found in rock salt, the same alkali, in form of a nitrate, should be discovered by Dr. Marcet, in the salt water of the ocean.

that are constantly taking place on the earth's surface, by the desiccation of lakes, in whatever manner accomplished. Our own country, with our immense lakes or inland seas, will one day exhibit a different picture to the eye of the geographer, the painter, and the geologist, from what it offers at present. If, as may readily be supposed, a vast lake once covered that portion of our country to the west of the Allegany Mountains, and which was eventually drawn off by the outlets cut by the St. Lawrence and the Hudson, through the Highlands of Montreal and New-York, we have an idea upon a grand scale of what will, at some future day, be the effect of draining our northern lakes. The falls of Niagara, gradually receding to the outlet of Erie, will eventually discharge the waters of the great lake and its tributary streams into Ontario, to dash rapidly down the St. Lawrence to the Atlantic, or to be distributed slowly as from a reservoir.*

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* Lake Erie is the most shallow of all our northern lakes, and contains the least water. It has an average depth of 120 feet, and is elevated above the tide waters of the Hudson, at Albany, 568 feet; and about the same above the tide waters of the St. Lawrence. The difference of level between Lake Erie and Lake Ontario is 334 feet, leaving 231 feet for the difference of elevation between the bottom of Lake Ontario and the tide waters in the St. Lawrence River.

The bed of Erie will then form an extensive plain or valley, bounded by the distant hills, and watered by a small lake or river, which will give passage to the St. Clair and Huron, and form a prolonged channel to the River Detroit. Here the geologists of future periods will find a fresh water formation in successive strata upon the limestone bed. These strata will probably be a coarse sandstone with argillaceous marl, containing fresh water shells; among others, some of the Uniones, so well described by our colleague Mr. Barnes. These will be sedimentary fresh water formations produced almost entirely by mechanical means, *i. e.* the deposition of earthy matters, coarse or fine, envelloping organized bodies. They may have a different structure from other fresh water formations. The layers may be distinct and numerous, with a coarse sandy grain, having the usual perforations to manifest the extrication of gas

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The following is the quantity of water computed to be contained in our great nothern lakes.

| | Medium depth. | Superficial area in square feet. | Solid contents in feet. |
|---|---|---|---|
| Superior, | 900 feet | 836,352,000,000 | 752,716,800,000,000 |
| Huron, | 900 | 557,568,000,000 | 501,811,200,000,000 |
| Michigan, | 900 | 376,898,400,000 | 339,208,560,000,000 |
| Erie, | 120 | 418,176,000,000 | 50,181,120,000,000 |
| Ontario, | 492 | 200,724,480,000 | 98,756,444,160,000 |
| | | 2,389,718,880,000 | 1,659,237,644,160,000 |

from the limestone beneath. It may be similar to the fresh water formations of Paris and Rome: or may resemble the *molasse* of Switzerland

But we need not look either into ancient records, nor into futurity, to know that both salt and fresh water lakes have covered much of the earth; and that they have, and do, and, from analogy, will form deposits of soils and minerals. Salt lakes still exist in many places, as is known to us all. The zout pans, in the south of Africa, are salt lakes furnishing that country with salt. Some of them are more famous than others; but all are situate on a plain, at a considerable elevation above the sea; none being less than one hundred feet above it. A brief account of one will suffice for the rest. The greatest part of the bottom of the lake is covered with one continued body of salt, like a sheet of ice, the crystals so united as to form one solid body as hard as rock. The shore is similar to the sandy beach of the sea coast, covered with sandstone and quartzose pebbles. At this beach begins a thin crust of salt, increasing in thickness and solidity as it advances to the middle of the lake. Near its margin, where it is four or five inches thick, the salt is taken out with pick-axes, and is fit for use. The thickness of this bed at the

middle has never been ascertained, as the waters do not subside. In endeavouring to account for the accumulation of pure crystallized salt at the bottom of this lake, it might be considered an explanation sufficiently satisfactory, to say, the waters on the south coast of Africa contain a high proportion of salt. During the strong south-east winds of summer, the sea spray is carried a great distance into the country, in the shape of thick mist. The powerful and combined effects of the dry wind and sun carry on a rapid evaporation of the aqueous part of the mist, and, of course, a disengagement of the saline particles, which fall on the ground and the foliage of the shrubbery. When the rains commence, they are dissolved and carried in solution to the salt pan, towards which the country on every side inclines.

The quantity of salt thus taken from the sea, and borne into the country, is so very great, that at the distance of many miles from the coast, the air is preceptibly saline when walking against it. The atmosphere is obscure, and objects at a short distance are not seen. These winds last for nearly two thirds of the whole year, and it is easy to conceive that in the lapse of ages an immense accumulation of salt can thus be formed. This lake is in red sandstone,

and the salt is in some places tinged with the red colour of the oxide of iron.

In Mexico the salt lake of Pennon Blanco, already noticed, yields annually 250,000 fanegas of unpurified salt, of 400lbs. each, making an aggregate of about 1,785,714 bushels.

Turks Islands are celebrated for salt ponds, which in some years have yielded more than 30,000 tons of salt for exportation.

The occurrence of rock salt deep under the surface of the earth, or high above the level of the sea, forms no objection to its being a deposit from water, since all geologists allow, and undoubted facts prove, that the ocean once covered all the continents now known. Whether the earth has been elevated above the sea, or the sea depressed beneath the level of the earth, the valleys must have been filled with salt water, which, upon evaporation, deposited salt. At Cardona, and other places, it seems to have been deposited in the red sandstone, or rather to be enveloped by it. Some of these valleys occur at great elevation: thus, the one in which is deposited the salt mine of Tyrol is 5,000 feet above the level of the sea. In the deserts of Peru is one 10,000 feet, according to Ulloa, above the sea. Others again are at various

depths beneath the surface; thus, one in England is 245 yards, (735 feet) deep, being 140 yards, (420 feet) beneath the level of the ocean.

The difficulty which has been supposed to exist in accounting for the formation of strata under which rock salt is found, is in a great measure obviated by the organic remains found in them: proving that each stratum was once the uppermost and last formed on the globe, and was in turn covered by others at different and distant periods. In the same way there are many strata occasionally covering coal and beds of shale, abounding in vegetable impressions.

The situation of salt in beds or springs at the foot of mountain chains, as already mentioned, may in some measure tend to illustrate its formation, as it is probable, that they (the mountain chains) were once the boundaries of inland seas or lakes, when our continents and oceans bore a different relative position from what they now exhibit.

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The *Uses* of salt are numerous and important: perhaps much more so than is generally believed or understood. In the arts, manufactures and agriculture it holds a distinguished place among the most valuable articles employed.

An idea of its consequence may be gathered from the information given to the parliament of Great Britain, by Mr. Parkes, a practical chemist, who was examined at the time when that legislative body were about to repeal the salt laws of England. The slight abstract I shall give below will also exhibit the burden which those salt laws impose on the manufacturer in Great Britain. The following is a list of articles in the manufacture of which salt is used.

*Sal Ammoniac, or muriate of Ammonia*, is made in abundance from common salt, which contains 51 per cent. of muriatic acid.

The manufacture of this article was abandoned in England, in consequence of the heavy duty of £30 per ton, laid on salt. In consequence, however, of bittern from the salt works, being allowed in Scotland for the manufacture, the price has been reduced nearly one half, and it is now sold at £120 per ton.

In the manufacture of *Glass*, salt is largely employed ; soda, which is procured from common salt, is used for plate glass ; potash for flint glass, and common salt, mixed with kelp, for crownglass. In England the heavy duty on salt is almost a prohibition to its use for these purposes.

*Oxy-muriate of lime*, and other oxy-muriatic salts employed in bleaching are made from salt, and consume a large quantity of it in the manufacture.

*Spirit of salt, or muriatic acid*, requires large quantities of salt. Mr. Parkes consumed 20 tons yearly in the production of it; and at least 1000 tons are used for this purpose in England every year, notwithstanding the enormous duty. It is used in a variety of processes in dyeing and calico printing.

*Glauber's salt* is made from what remains in the stills after the distillation of muriatic acid. This residuum was formerly thrown away, until a person employed it in making Glauber's salt, when a duty of £30 per ton was laid on the article manufactured, since, however, remitted.

*Epsom salt* is produced entirely from salt, or the evaporation of sea water. The brine which yields 100 tons of salt, gives from four to five tons of this valuable article. Dr. Henry, the celebrated chemist of Manchester, has discovered a process of preparing it from magnesian limestone, and has reduced the price one half. It can be made still cheaper from sea water, for the employment of which, in England, a duty is laid.

*Magnesia* is made from salt brine, or sea water. The English duties are so high as to render it probable that both this and the preceding article will, in future, be obtained by Henry's process from magnesian limestone.

*Crystalized Soda* is also made from common salt; and if the latter, or sea water, could be obtained free of duty in England, it would supercede the importation of American or Russian pot and pearl ashes, and 10,000 tons would be used annually in Great Britain. Several hundred tons in washing alone.

*Barylla*, of an excellent quality, is made from salt. In the manufacture of *Hard Soap*, salt is a necessary ingredient.

*Corrosive Sublimate* is always made from common salt. It is not only a medicine, but is used extensively in calico printing, and in other arts. Salt is always used in making corrosive sublimate: every 6 lbs. of quicksilver require 12 lbs. of salt; and in making calomel every 9 lbs of quicksilver require 16 lbs. of corrosive sublimate.

*Patent Yellow* is also prepared from common salt.

In the *Fisheries*, in salting provisions for the sea service, and for exportation, salt is largely employed. For these purposes, however, it should contain no muriate of magnesia, which deliquesces and dissolves the salt. It is always present when salt is made by a rapid evaporation.

*Butchers*, *Morocco Dressers*, and *Skinners*, employ it in large quantities.

*Housekeepers* employ salt in quantities, of which

no accurate estimate can be made. By inquiring of the best bakers in this city I find that, upon an average throughout the year, $3\frac{1}{2}$ lbs. of salt are required for two barrels of flour, or $\frac{1}{2}$ lb. of salt to every bushel of flour. Hence it may be presumed, that every adult consumes an ounce of salt per week, or three and a quarter pounds per annum, in bread only. Thus, then, ten millions of people (our population) consume yearly, in bread 32,500,000 lbs. or 14,500 tons, or 580,360 bushels of salt. In England double this quantity would be consumed, since there a pound of salt is used to every bushel of flour.

In England the poor can scarcely purchase this necessary article; and it is supposed that three times the present quantity would be eaten if there was no duty. At present a poor man there, is thought to pay three per cent. of his income for salt. To use threepence worth of his own salt, a man must pay ten shillings, ($2 22) for permission. After having raised his own property from the earth, purified it, crystallized it, and fitted it for use, he must pay a fine of 40 times its value for the privilege of consuming it at his table. A bushel of 56 lbs. cost sixpence sterling; and for less than sixpence more can be transported to any part of the kingdom, but

3000 per cent. is levied on the first cost, and permits only a limited employment of it.

*Farmers* use great quantities in making butter and cheese, and for steeping wheat to prevent smut; for which purpose it proved the best in a trial of fourteen substances, simple and compound. Bishop Watson says, that in Northwich alone 3,000 tons of salt are annually sold to the farmers of that district.

In *Glazing Earthen Ware* much salt is consumed, and is far preferable to the preparations of lead, which are liable to be dissolved by vinegar, and eaten. In England the manufacturers of earthen ware sometimes pay one-twelfth of the real amount of their sales for salt.

Salt is likewise employed by iron founders in metallic cements, and in rendering bar iron very malleable. It is used by white smiths and cutlers in case-hardening, in tempering files, and some other edge tools; mixed with other substances, for reducing metallic ores, assaying minerals, and rendering metals fusible, by the refiners of silver, and to prevent the oxidizement of some metals. It is used to moderate the flame of combustible bodies; and is extensively employed by the philosophical and manu-

facturing chemist, and by the druggist for a variety of pharmaceutical purposes.

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In *Horticulture*, salt is much used, particularly in England, where its merits are better appreciated than with us. It prevents the depredations of insects on fruit trees, and, when properly applied, protects them from the honey-dew. Persons ambitious of having good cider orchards are advised to dig a small trench a few yards from each tree, and place within it a few pounds of s at which, by the rains, &c. is gradually conveyed to the roots, and produces the most desirable effects.

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In *Agriculture*, I regret to say, salt has not met the attention it merits in this country. In after years, perhaps, when soil becomes more valuable, we too may be driven, as they now are in many parts of Europe, to seek means of rendering bad land productive, and literally leave no stone unturned that can tend to accomplish the object.

In Europe much has been said and written to prove and to disprove the utility of salt as a manure. Without entering at all into their ideas of the modus

operandi, we may judge from the effects of experiment. I may say, however, that it has been supposed beneficial, in small quantities, by its tendency to promote putrefaction; and injurious in large proportion, because it then exerts its antiseptic powers. It has been supposed of benefit by destroying snails, grubs, and other animals in the ground.

It is observed by Dr. Darwin, that as it is a stimulus which possesses no nourishment, but may excite the vegetable absorbent vessels into greater action than usual, it may, in a certain quantity, increase their growth, by taking up more nourishment in a given time, and performing their circulations and secretions with greater energy. In a greater quantity its stimulus may be so great as to act as an immediate poison on vegetables, and destroy the motions of the vessels by exhausting their irritability.

The reports of experimenters on the use of salt, as a manure, have been as different as the soils on which their trials were made ; owing, in some measure, to causes which can never be foreseen or controled, and on which agricultural experiment so generally depends.

In soils of feruginous sand, brought to a proper consistence by mud, or clay, or marl, salt has been found to exert effects superior to eight out of ten of

the best manures. A quantity of ground was prepared, and divided into beds of forty yards in length, by one in breadth. The beds were then sowed and manured by the following substances, in the quantities mentioned :

1. No manure.
2. Salt, $\frac{1}{2}$ a peck.
3. Lime, 1 bushel.
4. Soot, 1 peck.
5. Wood Ashes, 2 pecks.
6. Saw Dust, 3 bushels.
7. Malt Dust, 2 pecks.
8. Peat, 3 bushels.
9. Decayed Leaves, 3 bushels.
10. Fresh Dung, 3 bushels.
11. Chandler's Graves, 9 lbs.

With the exception of chandler's graves, salt was decidedly the best of those used. On a trial of compounds, the combination of salt and soot was the best. The substances were mixed in the following order, and the same quantity of each employed as when used singly ;

1. Salt and Lime.
2. Salt, Lime, and Sulphuric Acid.
3. Salt, Lime, and Peat.
4. Salt, Lime, and Dung.

5. Salt, Lime, Gypsum, and Peat.
6. Salt and Soot.
7. Salt and Wood Ashes.
8. Salt and Saw Dust.
9. Salt and Malt Dust.
10. Salt and Peat.
11. Salt, Peat, and Bone Dust.
12. Salt and Decayed Leaves.
13. Salt and Pearl ashes.
14. Salt and Chandlers' Graves.

Perhaps this superiority may be accounted for by the quality of saline substances to attract moisture from the air ; for those beds where salt had been used were visibly and palpably moister than the rest, even for weeks after the salt had been applied ; and the appearance continued until rain fell, when, of course, the distinction ceased. In several instances the crop of the land failed altogether, except on the part where salt was applied.

It is to be remarked, that these observations apply particularly to what are called feruginous sandy soils ; so that they are adapted, in a good measure, to some part of our salt formation ; and much of the land lying between the Council Bluffs, and the Rocky Mountains, a band running parallel to the river Platte, is such, perhaps, as after ages may improve by the use

of the salt abounding in the rivers in that region. It will be long before the population of that section of the union will be sufficiently numerous to make it necessary to think of it. It will be at a period when all our national resources are brought into action.

In Hindostan and China all the land on the coast is regularly treated with sea water, and they depend solely on this management for the increase and goodness of their rice crops. In Poland salt is extensively used in the tillage of land.

Many valuable communications on the use of salt, as manure, have been made to the British Board of Agriculture. I may be allowed to mention two further experiments made on this subject.

To show the effects and advantages of salt properly applied to vegetables, the gardener to Lord R. Manners made the following experiment, in an extreme dry summer, upon a bare piece of pasture land, out of which the cattle were all taken for want of grass. He marked off four places, each of which was watered for nine successive nights, in the following manner: the first with one gallon of spring water; the second with a gallon of the same water, containing an ounce of common salt; the third with

the same quantity of water, and two ounces of salt; and the fourth with the same quantity of water, and three ounces of salt, which gave the following effects:

The grass in the second place grew more abundant, and of a darker green than that in the first; in the third place it grew only by spots, for part of it was killed where the greatest quantity of water fell; and the fourth was quite brown for a greater compass than the third: by which it appears that an ounce of salt in a gallon of water had a better effect than the water alone; and that three ounces of salt mixed in a gallon of water was more than the grass could immediately receive; but the fourth place, in the ensuing spring, was the most fertile of them all.

The other experiment I shall notice is related by Dr. Holland, well known by his agricultural survey of Cheshire, in England.

After draining a piece of sour rushy ground about the middle of October, he ordered some refuse salt spread upon a part of the land, at the rate of eight bushels to the acre, and in another part sixteen bushels. In a short time the vegetation disappeared totally, and during the month of April following not a blade of grass was to be seen. In the latter end of the month of May a most flourishing crop of rich grass made its appearance on that part where the eight

bushels had been laid. In the month of July the other portion produced a still stronger crop ; the cattle were remarkably fond of it ; and during the whole of the ensuing winter, (which is ten or twelve years since,) and to this day, the land retained, and yet exhibits, a superior verdure to the neighbouring closes.

In the memoirs of the Royal Academy of Sciences at Paris are several papers showing the great advantages resulting from the use of salt as a manure, in improving land, and increasing the number of cattle. It is there asserted that more than the usual quantity of working cattle on a farm gives a double advantage, by doing the work in season, and enriching more land by their additional manure. The difficulty of maintaining this additional number of cattle, without increasing the expense, is obviated by the use of salt. To prove which it is advanced :

1. That salt given with the food of cattle augments its nourishment.
2. That in proportion to the quantity of salt eaten by cattle, the effects of the augmentation are perceived.
3. That no ill consequences follow its use, even when given without stint.

These propositions are supported by unquestionable evidence, and the trials of very many persons.

Crau, in the jurisdiction of Arles, in the county of Provence, France, has an extent of six leagues by three, the whole surface of which is covered with small rough stones, and not a tree or bush is to be seen upon the whole district, except a very few scattered on the border; yet on this apparently barren spot, by the free use of salt, more numerous flocks of sheep are bred and reared than upon any other common of equal extent in the kingdom; and what is not less remarkable, the sheep are healthier, hardier, and endure the severity of the winter with less loss, though they have fewer sheep cotes for covering, than those fed and bred in more luxuriant pastures, and that have the advantage of convenient shelter. Add to this, that the wool of the flocks bred and brought up in the Crau is not only the finest, but bears the highest price of any in France. It is concluded, that these surprising effects are consequent upon the unlimited use of salt: for it frequently happens that the Crau is so parched up in summer, that the animals are obliged to turn up the very stones to get the few blades of grass that grow round them, and yet none perish for want of food. Allowing

every excellence that can possibly be supposed inherent in the herbage, yet the quantity of it is so small, that without the abundant use of salt, a fourth part of the sheep kept in the Crau could not subsist on it.

The second proposition can be proved by an experiment, which every farmer can make, simply by giving salt to one half of his cattle, and none to the other half: in less than a month there will be a perceptible difference in the appearance of the animals, in the sleekness of their coats, in their growth, and in their strength and firmness of labour; and these effects will be produced by little more than half their usual food.

The third proposition is supported by the practice in Arles, where the cattle have as much salt as they can eat, and none are so healthy, or thrive so fast, as those that eat most of it.

In Spain, where the finest wool in the world is produced, large quantities of salt are given to the sheep; to which they attribute, in a great measure, the fineness of the wool.

In England a thousand sheep consume at the rate of a ton of salt annually. It is supposed to destroy the fasciola hepatica, or fluke worm.

It has long been a practice in our country to give salt to horses, and to milch cows. It will be seen in an appendix, how great is the quantity given to animals in England.

# APPENDIX.

## No. I.

As salt is extensively used in our fisheries, manufactures, and agriculture, I have stated below the value of our exports during the commercial year of 1822, which will show the value of those branches of trade in which this useful article is employed.

| | Value. |
|---|---|
| *Fisheries*, | $ 1,384,539 |
| *Agriculture*, | 41,272,379 |
| *Manufactures*, | 2,483,052 |
| Forest, | 3,815 542 |
| Uncertain, | 918,567 |

## No. II.

In order to show the quantity of salt that would be used yearly in Great Britain and Ireland, in case the duty on it was repealed, as well as to show the quantity used in those countries for different purposes, and to exhibit the oppression of the salt duty, I copy the estimate made by Mr. Parkes.

| | Tons. |
|---|---|
| 28,972,000 acres of meadow and arable land, | 1,298,850 |
| 1,790,000 horses and colts, | 537,000 |
| 3,684,000 cows, oxen, and calves, | 1,094,400 |
| 26,148,463 sheep and lambs, | 26,184 |
| Butter, cheese, hay, &c. for farming purposes, in addition to what is now used, | 10,000 |
| Domestic general purposes, additional, | 20,000 |
| Trade and manufactures, do. | 40,000 |
| Increased quantity for the fisheries, | 30,000 |
| | 3,056,398 |
| Add for Scotland and Ireland one half of the consumption of England | 1,528,199 |
| | 4,584,597 |
| Exports, as at present, | 140,000 |
| | 4,724,597 |

Mr. Parkes makes a deduction of one half for the people not being accustomed universally, at present, to the use of salt; but that is probably owing to its present price, far above the reach of the very poor.

| | | |
|---|---|---|
| In case, then, of a repeal of the salt duty, there would be used and exported—tons | | 4,724,597 |
| Present exports and fisheries amount to | 140,000 | |
| Present home consumption | 55,000 | |
| | | 195,000 |
| Leaving an annual amount of | | 4,529,597 |

Or nearly 162 millions of bushels, which British subjects are now prevented from using by the enormous tax of their government on this useful and almost necessary article.

## No. III.

*The following interesting extracts are from a Letter received, in answer to some Queries, from C. Tyler, Esq. and which arrived after these pages went to press.*

"When were the salt springs first discovered?"

In the month of April, in the year 1788, I removed from Johnstown, in the county of Montgomery, with the family of Gen. Asa Danforth, (having previously obtained the permission of the Indians,) to Onondaga Hollow. About the same period I was informed that Sir William Johnson had, several years before, obtained a deed of a tract one mile in width adjoining, and including the entire lake, and that he made the purchase on account of some salt water which had been discovered upon the margin of the lake.

In the month of May, of the same year, the family wanting salt, obtained a small quantity (about a pound) from the Indians, which they had made from the water of the springs upon the shore of the lake. The Indians (then very friendly) offered to discover the water to us. Accordingly, I went with an Indian guide to the lake, taking along an iron kettle of fifteen gallons capacity; this he placed in his canoe, and steered out of the mouth of the Onondaga Creek, (where we then were,) then easterly into a pass, now called Salt or Mud Creek. After passing over the Salina Marsh, then flowed about three feet with water, and steering towards the Bluff of hard land, (now

the village of Salina) he stopped his canoe about one hundred feet from the land, and fastening it by a pole which he put down in the mud, pointed down into a hole, apparently artificial, and told me there was the salt. I soon distinguished the salt water from its ocherous colour, the fresh water being on the top ; I put down a bucket into the spring, and on lifting it out, found I had salt water.

I went on shore, put up crotches, suspended my kettle, and with the canoe and bucket, obtained water to fill it, and in about nine hours I boiled about 30lbs. of salt, retaining all the impurities contained in the water. It had, however, some of the properties of salt, and relieved us from our necessities.

We continued to make salt in this way during that year, and until December, 1789, when a man by the name of Nathaniel Loomis (then a settler in Whitesboro) came on with a few kettles by the way of Rome and Wood Creek, and in December, 1789, and winter of 1790, made from 5 to 600 bushels of salt ; and although of an indifferent quality, sold it for one dollar per bushel ; those works were kept in operation nearly or about two years.

" What are the Indian traditions concerning them ?"

The traditions of the Indians are vague and indefinite, and do not mention the time when the springs were first discovered.

" In what order were they discovered ?"

Salt was made by the Indians, both from the springs around Onondaga Lake and at Montezuma, when I first came to Onondaga, but which were first discovered I cannot say.

"To whom did they belong?"

To the Indians, and were obtained from them by treaty. The springs at Montezuma are private property.

"At what depth are the springs, and what are the strata above them?"

The salt water used at Montezuma was obtained, by the Indians, by digging small holes in the ground, a foot or two in depth, in the marsh at the foot of the ridge upon which the village now stands. The water came through smalls trata of quicksand. Afterwards wells were sunk by the whites to various depths, from 14 to 50 feet, from which water of the same quality with that which was first discovered was taken in sufficient quantities to make considerable salt. The water, however, was weak, yielding about eight ounces to the gallon.

About 1807, Gen. John Swartwout began to manufacture salt from salt water discovered in a branch of the Seneca River, since called Salt Creek, at the depth of about 8 or 12 feet from the surface. This water was of a quality like that first used; the fresh water was partially excluded by means of a curb.

In the year 1810, under the direction of the Cayuga Manufacturing Company, a well was sunk on the west side of the ridge of ground upon which the village now stands, to the depth of something more than one hundred feet. In sinking this well three separate springs of water were discovered: the first, like that which had been previously used, about ten feet from the

surface. Then succeeded a stratum of fine blue clay, five or six feet in depth ; then a stratum of hard pan, with occasionally some gravel, about thirty-five feet in depth ; then a thin stratum of quicksand, containing a little weak brine, having about ten ounces to the gallon ; then succeeded thin irregular strata of sand and clay, with some water, until they reached to the distance of a hundred feet, where they found the great fountain of water, which came in through a body of quicksand. This water, when pure and unmixed with the upper veins, produced about twenty ounces to the gallon. Another well was sunk on the east side of the ridge, and the great fountain was found at the depth of eighty feet. The geological appearances were like those in the first well. Another well is partly completed in this place : it is now sunk to about the depth of fifty feet, and the geological appearances are much the same as in the other wells, except that the upper vein of water is more abundant than in the other wells, and the sand deeper.

The foreign matter is essentially the same as at Salina.

The strength of the water now used from our wells, compared with that of Salina, is about as nine to twelve.

The amount manufactured at these works last year was between 16 and 20,000 bushels, 1,000 of which was made by solar evaporation. No kettles are used, but large pans of wrought iron, which were made in Liverpool, England. Only six of these were in operation last year ; more have heretofore been in operation. Twelve or fourteen will be in operation next year.

No rock salt has ever been found here.

The hills and ridges run almost due north and south, and the soil is generally gravelly ; the pebbles being round and smooth.